Automated Fiber Placement of Thin-Ply Composite Materials for Large Aerospace Structures, Phase I

Completed Technology Project (2018 - 2019)

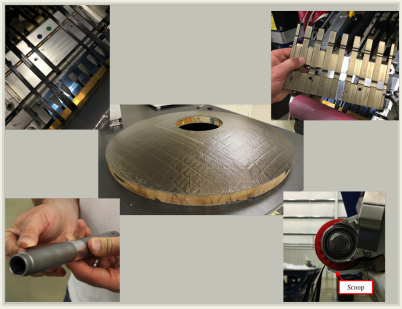
Project Introduction

Leveraging their prior experience working with automated fiber placement (AFP) of thin-ply composite materials, NextGen Materials & Processing LLC and the University of Massachusetts Lowell will utilize a Design of Experiments approach, combined with analytical modeling, to identify the critical material, slitting, spooling, and AFP parameters that influence the repeatable, high quality laydown of thin-ply composite materials to produce large aerospace structures. To date, long and costly certification processes have hindered the widespread adoption and exploitation of the benefits of thin-ply composites with AFP. Without critical end-user feedback, material manufacturers haven't fully developed their thin-ply material systems with the same repeatability, consistency, and quality of standard-ply-thickness composites. Thus, further process development is necessary to optimize thin-ply unidirectional tapes for AFP. Working closely with Hexcel, the NextGen/UMass Lowell team will develop AFP-optimized conditions for a thin-ply version of the IM7 carbon fiber/8552-1 epoxy prepreg system, independent of different types of AFP machines. Using this material in conjunction with AFP, mechanical test coupons will be fabricated and tested to produce data for contribution to the development of the design and qualification database for thin-ply composite materials that will accelerate the adoption of these materials in structural applications.

Anticipated Benefits

This program will lead to more efficient AFP processing of thin-ply composite materials, enabling various manufacturing applications for NASA including aerostructures requiring high structural efficiency, and lightweight deep-space exploration structures such as pressurized habitation systems and tanks. Having the ability to manufacture cost-efficiently will also enable low-mass high stiffness deployable structures that can be packaged efficiently during launch (via folding/rolling).

Non-NASA commercial applications of AFP of thin-ply materials include commercial rockets requiring advancements in materials and processing technologies to reduce cost, weight, and improve structural performance. Non-space applications include UAVs staying aloft for long durations to provide internet to remote global regions. Supersonic and hypersonic aircraft can be manufactured with reduced lifecycle costs due to the improved damage tolerance and reduction in repair and maintenance activity.



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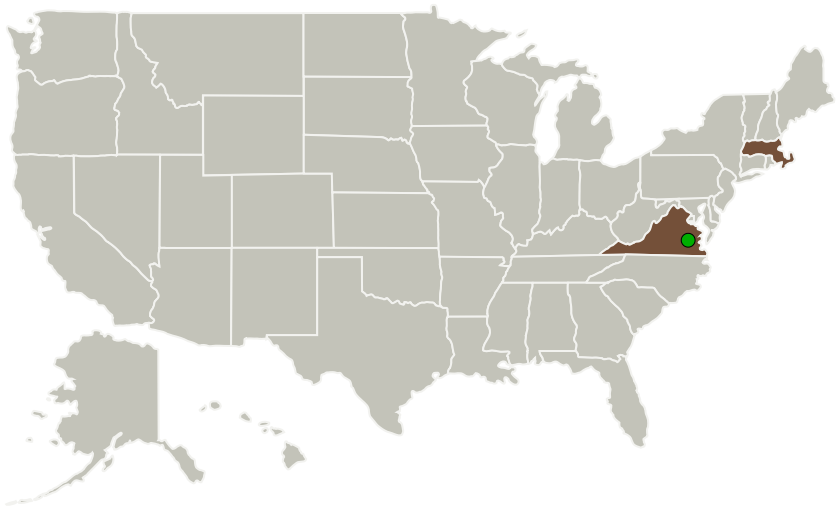
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
NextGen Materials & Processing, LLC	Lead Organization	Industry	Tewksbury, Massachusetts
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia
University of Massachusetts-Lowell	Supporting Organization	Academia	Lowell, Massachusetts

Primary U.S. Work Locations	
Massachusetts	Virginia

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

NextGen Materials & Processing, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

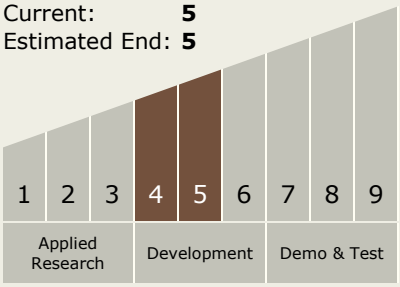
Carlos Torrez

Principal Investigator:

Christopher Hansen

Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **5**



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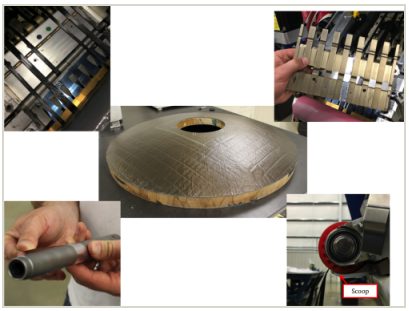
August 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141285)*

Images



Briefing Chart Image
Automated Fiber Placement of Thin-Ply Composite Materials for Large Aerospace Structures, Phase I
(https://techport.nasa.gov/image/136076)

Final Summary Chart Image
Automated Fiber Placement of Thin-Ply Composite Materials for Large Aerospace Structures, Phase I
(https://techport.nasa.gov/image/128335)

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.1 Materials
    - TX12.1.1 Lightweight Structural Materials

Target Destinations

The Moon, Mars, Earth